MONTHLY WEATHER REVIEW.

OCTOBER, 1894.

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INTRODUCTION.

The REVIEW for October, 1894, is based on reports from 3,340 stations occupied by regular and voluntary observers. These reports are classified as follows: 150 reports from Weather Bureau stations; 39 reports from U. S. Army post surgeons; 2,199 monthly reports from State Weather Service and voluntary observers; 32 reports from Canadian stations; 221 reports through the Southern Pacific Railway Company; 536 marine reports through the co-operation of the Hydrographic Office, Navy Department, and "New York Herald Weather Service;" monthly reports from 32 U. S. Life-Saving stations; 60 reports from navigators on the Great Lakes; monthly reports from local services established in all States and Territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

The WEATHER REVIEW for this month has been prepared under the general editorial supervision of Prof. Cleveland Abbe. Unless otherwise specifically noted, the text is written by the editor, but the statistical tables are furnished by the Division of Records and Meteorological Data, in charge of Mr. A. J. Henry, acting chief of that division.

CHARACTERISTICS OF THE WEATHER FOR OCTOBER, 1894.

The most prominent features of the month of October were the hurricane that passed over the south Atlantic States on the 8th and 9th, and those that passed parallel to the Atlantic coast some distance to the eastward on the 16th and 20th and on the 25–27th. The temperature throughout the United States averaged a little above the normal, and many stations reported the highest mean temperature on record. The precipitation was generally below the normal in the interior of the country, but above the normal in New England, the Middle States, and on the coast of Washington. The current REVIEW contains the first of a series of new chapters on the humidity of the atmosphere and on the relations between meteorology and terrestrial magnetism.

ATMOSPHERIC PRESSURE.

[In inches and hundredths.]

The distribution of mean atmospheric pressure reduced to sea level, as shown by mercurial barometers not reduced to standard gravity and as determined from observations taken daily at 8 a. m. and 8 p. m. (seventy-fifth meridian time), during October, 1894, is shown by isobars on Chart II. That portion of the reduction to standard gravity that depends on latitude is shown by the numbers printed on the right-hand border. This Chart also gives the so-called resultant wind directions for this month, based on the data given in Table IX of this REVIEW.

During the current month of October the highest mean pressures have been: 30.08, Augusta; 30.07, Atlanta, Chattanooga, and Memphis; 30.06, Galveston, Palestine, Knoxville, and Montgomery. On the Pacific coast the highest pressures have been: 30.09, Salt Lake City; 30.07, Idaho Falls and Carson City; 30.06, Winnemucca.

The lowest mean pressures were: 29.83, Duluth and Port Arthur; 29.85, Moorhead; 29.86, St. Vincent and Marquette; 29.87, Williston; to the northward of this region the lowest pressures at Canadian stations were: 29.82, at Calgary and Battleford; the low area of the Gulf of California is shown by the means 29.86, Yuma; 29.93, Tucson; 29.95, San Diego.

The normal distribution of atmospheric pressure and normal resultant wind direction for the month of October were approximately shown on Chart V of the REVIEW for October, 1893, as computed by Prof. H. A. Hazen, and are not now reproduced. As compared with the normal for October, the mean pressure for the current month was deficient at all stations, except Halifax and Sydney. The region of greatest deficit was in the upper Mississippi and lower Missouri valleys and the Lake region, where the average deficit was about 0.14; the maximum deficits were 0.17 at Duluth and Port Arthur, and 0.15 at Green Bay, Davenport, Moorhead, and Winnipeg, Manitoba. On the Pacific coast pressures were generally deficient; but a region of slight excess, 0.01, extends from San Francisco to Santa Fe.

As compared with the preceding month of September, the pressures reduced to sea level show a rise throughout the eastern slope, Rocky Mountain and Pacific coast stations, the maximum being: 0.11, Idaho Falls and Fresno; 0.10, Salt Lake City and Sacramento; 0.09, Winnemucca and Carson City. From the Mississippi eastward to the entire Atlantic coast the mean pressure had fallen, the largest falls being: 0.15, Yarmouth; 0.14, Father Point, Halifax, Eastport, Northfield, and Rochester; and 0.18, Rockliffe.

DIURNAL VARIATIONS.

The systematic periodic diurnal variations of pressure are shown by the hourly means given in Table VI.

AREAS OF HIGH AND LOW PRESSURE.

The following sections give some details as to the phenomena attending the individual areas of high and low pressure. The storm warnings officially issued by the Weather Bureau either through the general forecast official at Washington, or by the respective local forecast officials, are enumerated in connection with the respective areas of disturbance.

MOVEMENTS OF CENTERS.

The following table shows the date and location of the center at the beginning and ending of each area of high or low pressure that has appeared on the U. S. Weather Maps during the month, together with the average daily and hourly velocities. The monthly averages will differ according as we consider each path as a distinct unit, or give equal weight to each day of observation; in the first case the monthly average is taken by paths, in the latter case by days.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	1, a. m.	40	86	2, a. m.	33	77	700	1.0	700	28.3
II	1, a. m.	37	120	8, a. m.	44	64	3,700	7.0	529	22.0
III	5, p. m.	45	125	9, a. m.	31	98	2,300	3.5	657	27.4
IV	8, a. m.	46	126	12, p. m.	39	73	3,400	4.5	756	31.5
V	11, p. m.	48	126	16, a. m.	36	81	3,000	4.5	667	27.8
VI	14, p. m.	43	116	19, a. m.	37	72	3,350	3.5	957	39.9
VII	16, a. m.	50	125	17, a. m.	51	109	800	1.0	800	33.3
VIII	20, p. m.	51	69	25, a. m.	44	58	1,350	4.5	300	10.7
IX	21, p. m.	44	112	24, p. m.	48	80	1,650	3.0	550	18.3
X	24, a. m.	37	125	27, a. m.	33	95	2,300	3.0	767	32.0
XI	26, p. m.	41	126	31, a. m.	34	105	2,600	4.5	578	24.1
XII	27, p. m.	45	81	30, p. m.	47	58	1,700	3.0	567	23.6
Sums							26,850	43.0	7,828	
Mean of 12 paths									652	27.2
Mean of 43 days									624	26.0
Low areas.										
I	1, a. m.	46	106	7, a. m.	50	55	2,500	6.0	417	17.4
II	1, a. m.	41	66	2, p. m.	47	52	850	1.5	567	23.6
III										
IV	2, a. m.	14	78	11, a. m.	51	66	3,400	9.0	378	15.8
V	5, a. m.	31	115	10, a. m.	48	53	3,500	5.0	700	29.2
VI	5, p. m.	37	125	6, p. m.	39	122	150	1.0	150	6.3
VII	7, p. m.	52	120	10, a. m.	47	85	1,600	2.5	667	27.8
VIII	10, a. m.	55	111	12, a. m.	54	90	900	2.0	450	18.8
IX	11, a. m.	40	98	15, p. m.	65	130	1,900	4.5	422	17.6
X										
XI	12, p. m.	54	117	18, p. m.	50	55	3,200	6.0	533	22.2
XII	10, a. m.	12	64	22, a. m.	45	33	3,600	12.0	300	12.5
XIII *a*	16, a. m.	39	125	21, a. m.	48	93				
XIII *b*	18, a. m.	39	102	21, a. m.	48	93				
XIII *c*	18, p. m.	49	124	21, a. m.	48	93				
XIV	22, a. m.	23	67	31, a. m.	53	27	4,000	9.0	444	18.5
XV	20, a. m.	41	125	22, a. m.	51	110	800	2.0	400	16.7
XVI	22, p. m.	43	126	29, p. m.	40	68	4,100	7.0	586	24.4
XVII	25, p. m.	55	115	31, p. m.	46	74	3,000	6.0	500	20.8
XVIII	29, a. m.	54	120	31, p. m.	53	101	800	2.5	320	13.3
XIX	31, p. m.	55	49							
Sums							34,300	76.0	6,834	
Mean of 15 paths									456	19.0
Mean of 76 days									451	18.8

HIGH AREAS.

I.—This appeared on the 1st, a. m., in central Indiana, and was a continuation of high No. XIV of the September REVIEW. It moved southeast and disappeared on the 2d off the south Atlantic coast.

In connection with this area, frost warnings were issued as follows: 1st, 8 a. m., eastern portion of Ohio.

II.—On the 1st, a. m., pressure was rising off the coast of California, and the central high pressure, after pushing eastward, was, on the 4th, a. m., central in Utah, while low No. I had moved southeast to Lake Superior. After this date the high pressure extended south and east and on the 6th turned northeastward to the middle Atlantic coast, disappearing on the 8th off Nova Scotia.

In connection with this area, frost warnings were issued for western New York on the 6th, a. m.

III.—On the 5th pressure rose off the coast of Oregon and British Columbia, and by the 7th, a. m., it was highest over Idaho and Montana. It then stretched southeastward into Texas, where it disappeared on the 9th, while the high area following it was advancing over a similar course.

In connection with this area, the following cold-wave signals were ordered: 6th, p. m., Huron and Moorhead; 7th, a. m., Yankton, Omaha, Concordia, Wichita, Topeka, St. Paul, Minneapolis, Des Moines, Dubuque, Davenport, Keokuk, Sioux City, and La Crosse.

IV.—This began, like its predecessor, over Oregon and Washington on the 8th and was, on the 10th, a. m., central in Idaho. At this time Nos. III and IV constituted a ridge extending from the Gulf States northwestward beyond our stations. By the 11th, a. m., No. IV was central in the Gulf States, after which it turned northeastward and disappeared on the 12th, a. m., off Cape Hatteras.

In connection with this area, frost warnings were issued for the District of Columbia, Maryland, and Virginia on the 10th, a. m.

V.—On the 11th, while a ridge of high pressure extended over the south Atlantic and Gulf States, pressure again began to rise in Oregon, and by the 12th, a. m., high area No. V was central in Idaho and western Montana. At this time high No. IV was central in Virginia, and a very slight trough between these two high areas extended from Texas to Lake Superior. This trough developed into low area No. IX, and apparently furnishes an example of the origin of a cyclone between two anticyclones. By the 14th, a. m., high No. V extended as a long oval from Lake Superior to Louisiana, and by the 16th, a. m., it was central in the south Atlantic States, where it then disappeared in the presence of the advance of another area, No. VI, which was then central in Colorado. Together these constituted a ridge of high pressure extending from the Atlantic coast and Bermuda westward over the Gulf States and northwestward to Oregon, where high area No. VII was at that time approaching. This ridge undoubtedly represents the tropical belt of high pressure, which on an ideal globe of uniform surface would extend east and west along the parallel of 30°, but in the present case pursued that parallel from the mid-Atlantic to Texas only, and trended northwestward to Alaska. The diversity of the continental and oceanic surfaces and the extended areas of storm and rain so completely break up the ideal circulation into large oceanic and continental areas that the latter offer problems of the highest importance to the students of the mechanics of the atmosphere.

In connection with this area, the following frost warnings were issued: 14th, 8 a. m., for the interior of the Atlantic coast districts; 14th, 8 p. m., for the interior of North Carolina, the northern portion of South Carolina, and the interior of Georgia.

VI.—On the 14th a slight rise occurred on the Rocky Mountain plateau region, which, on the 8 p. m. map, is considered as central in southern Idaho, while low pressure No. X was in Arizona and No. XI in Alberta. This high pressure area was essentially a portion of the belt of high pressure that continued prominent during the first half of the month in the region between Oregon and the south Atlantic coast. It moved slowly southeastward and was barely recognizable as a special high pressure on the 17th in the Gulf States, but afterwards again became prominent as it moved northeastward, and finally disappeared on the 20th off the middle Atlantic coast.

VII.—On the 16th, a. m., pressure was high in British Columbia, as previously stated. This area moved eastward across the mountains, and on the 17th, a. m., was central in Saskatchewan, after which it merged into No. VI.

VIII.—On the 20th, p. m., pressure rose in the St. Lawrence Valley and the region to the northward, indicating a flow of air toward low pressure No. XIII, which was then central in the eastern portion of North Dakota. The highest pressure remained in Labrador north of our stations until the 24th, p. m., and disappeared on the 25th off the coast of Nova Scotia and Newfoundland, having materially contributed to the growth of low No. XIII and to the hurricane (low No. XIV) as it moved from the West Indies northward toward New England.

IX.—On the 21st, p. m., an extensive area of high pressure, which apparently had advanced southeastward over California and Nevada, became central in Idaho. By the 23d, a. m., it was central in Nebraska, while the extensive low pressure No. XVI was advancing into Washington and the hurricane (low No. XIV) was central in the Bahamas. The central portion of the country was now occupied by a high area that extended from the Gulf of California and the Gulf States northward to Hudson Bay. By the 24th, a. m., the region of highest pressure had receded northward to Lake Superior, and after this disappeared from the map, while area No. VIII represented the eastward movement of the high pressure through the Dominion of Canada.

X.—On the 24th, a. m., pressure was rising on the coast of California and Oregon, and on the 25th, a. m., the highest pressure was central in Idaho. After this northeastward movement the center turned to the southeast and disappeared on the 27th, a. m., in the west Gulf States.

In connection with this high area, the following cold-wave signals were ordered: 25th, a. m., Rapid City, Pierre, Huron, Yankton, Denver, Pueblo, Valentine, North Platte, Omaha, Concordia, Wichita, Dodge City, and Kansas City.

XI.—On the 26th, p. m., pressure was rising on the coast of Oregon while low No. XVII was moving southeastward from Stikine to Dakota. On the 28th the center had moved southeastward into northern Nevada, after which the area of high pressure expanded, covering the whole of the Rocky Mountain plateau region on the 29th without much change in the location of the central maximum pressure. During the 30th the ridge of high pressure gradually diminished, and by the 31st, a. m., had disappeared from the Rocky Mountain region, but leaving an area of high pressure in the Gulf of Mexico.

In connection with this high area, cold-wave signals were ordered as follows: 27th, a. m., Rapid City, Cheyenne, Denver, Pueblo; 28th, a. m., Omaha, Concordia, Wichita, Topeka, Moorhead, St. Paul, Duluth, Minneapolis, Des Moines, Dubuque, Davenport, Keokuk, Sioux City, Springfield, Ill., Columbia, Kansas City, and La Crosse.

In connection with this high area, the following frost warnings were issued: 30th, 8 a. m., for the western portion of North Carolina and South Carolina, the northern portion of Georgia, the interior of western Florida, Alabama, Mississippi, Louisiana, Arkansas, and Tennessee.

XII.—On the 27th, p. m., an area of moderate high pressure had descended southward over the Lake region, coming in between the hurricanes low No. XVI, which was then off Cape Hatteras, and the low pressure No. XVII, which was then central in South Dakota. This area of high pressure moved eastward and disappeared on the 29th in New England, but reappeared and finally disappeared on the 30th south of Newfoundland. Its existence and movement were intimately associated with the movement of the hurricane center.

LOW AREAS.

I.—On the 1st, a. m., this low area was central in Montana, being a continuation of low No. XV of the series for September. After advancing southeast into North Dakota it moved eastward and disappeared over Newfoundland on the 6th; extensive areas of light rain accompanied this low pressure both in the front and rear.

In connection with low area No. I, the following signals were ordered: 1st, 8.22 p. m., storm northeast, at Duluth and Ashland section; southeast at lakes Pepin and Michigan, and information at Houghton and Sault Ste. Marie. 2d, 9 a. m., storm southwest, lakes Pepin, Huron, and Superior, except Duluth and Ashland section. 2d, 10.30 a. m., storm southwest at stations on Lake Erie, except Detroit. 2d, 7 p. m., changed to storm northwest, Lake Pepin, Duluth, and Ashland sections; changed to storm southwest, Houghton, Marquette, Sault Ste. Marie, and Lake Michigan. 3d, 9.45 a. m., storm southwest, Lake Ontario; 7 p. m., storm northwest, lakes Pepin, Superior, and Michigan. 4th, 9.30 a. m., storm southwest continued, Lake Huron; 7 p. m., storm northwest continued, lakes Pepin, Superior, and Michigan; changed to northwest, Lake Huron.

II.—This was a continuation of the low area hurricane No. XII of September. On the 1st it passed northeastward some distance off the coast of New England and Nova Scotia, and its further history belongs to the chapter on North Atlantic Meteorology.

The signals and storm warnings that had been issued during the 30th of September remained until the 1st of October, and no new signals were necessary for stations in the United States.

III.—This number is given to the depression that frequently appears extending northward over the Gulf of California and Arizona. The principal dates of low pressure at Yuma are given on Chart No. I, and are as follows: 2d, p. m., 29.78; 5th, p. m., 29.68; 10th, p. m., 29.74; 14th, p. m., 29.70; 18th, p. m., 29.67; 24th, p. m., 29.90; 26th, p. m., 29.80; 31st, p. m., 29.85. It generally happens that the formation of low areas in this region occurs simultaneously with the appearance of a low area north of Oregon and Washington as though both depressions depended upon the retreat westward of the high pressure off the Pacific coast, or as though both depended upon the advance of a wave of low pressure eastward over the Pacific coast. There is no apparent connection between the dates of these depressions and the phases of the moon, so that the hypothesis of a lunar tidal action does not seem to be well supported. The exact nature of the mechanical origin of these depressions is, therefore, still a matter of uncertainty; the mere statement that the Arizona low pressure is an extension northward of the equatorial belt of low pressure and that the northern low pressure over British Columbia is an extension southward of the low area of the Aleutian Islands does not explain their origin or their mechanical connection with each other. It is very possible that the forces acting upon the atmosphere of the Pacific Ocean are so adjusted to the mass of that atmosphere and the resistances to its motion, that when any movement is once established it must proceed in a rythmic or nearly rythmic succession of movements that are interfered with principally by the rain and clouds to which they give rise.

The low pressure above enumerated, namely 29.74 on the 10th, p. m., represents an area (see No. X in the following series) which hovered about this region until the 14th without any well-marked area of high pressure intervening.

IV.—This was a hurricane which first became severe at Weather Bureau stations on the 7th, but by means of a few reports from Central American and West Indian stations the earlier history of this depression may be traced from its beginning on the 1st in the southern portion of the Caribbean Sea off the northern coast of Colombia, South America. On that date an area of high pressure was moving rapidly south-

ward over the United States and Cuba, and pressure was falling in the States of Nicaragua and Panama. By the 2d, a. m., the surrounding winds indicated a whirl central a little east of Roncador reef. This whirl moved northeastward, passing midway between Cuba on the right hand and Nicaragua, Honduras, and Yucatan on the left hand. Shut in by these land areas it apparently did not grow in size, but may have been as intense at the center as it was in the subsequent part of its path.

The general depression within which this area occupied the southern portion was at first a continuation of that which also contained the hurricane designated as No. XII in the September REVIEW, but subsequently this hurricane in the Caribbean Sea entered the region of low pressure whose northern portion was occupied by low No. I of the present month. On the 5th as low No. I passed rapidly eastward over Newfoundland the present hurricane was moving slowly northward through the eastern portion of the Gulf of Mexico, and was fed on its western side by high area No. II which was then central in Kansas and Missouri. As this high area moved rapidly eastward the hurricane entered the general depression containing low No. V, which was central on the 7th in Minnesota. During the 8th and 9th the centers of these two low pressures rapidly approached each other; No. V went rapidly eastward toward Newfoundland while No. IV went rapidly northeastward over Florida and Georgia. Meanwhile a third low area (No. VII) had advanced from British Columbia southeastward, and by the 10th, a. m., was central over Lake Superior when No. IV was central off the coast of New Jersey and No. V was central in Newfoundland. These three centers thus formed the vertices of a triangle whose three sides were about twenty degrees in length. From this point onward, the record seems to show that low No. VII rapidly dwindled away while Nos. IV and V passed on to the Atlantic Ocean.

The following reports from Weather Bureau stations show the times of beginning and ending of this storm:

Mobile, Ala., rain began 7th, 8.45 p. m., with high wind, and continued until 8th, 5.45 p. m.

Fort Morgan, Ala., 7th, 8 a. m., 29.85, east to northeast 22 miles, high tide and heavy sea; 4 p. m., rain began; 8 p. m., 29.75, east-northeast 32 miles. 8th, 8 a. m., 29.43, northeast 53 miles, light rain, tide water 5 feet above ordinary high tide, very heavy sea; 10 a. m., 29.35, 60 miles northeast; 11.55 a. m., 29.30, 60 miles; 2 p. m., 29.24, wind 62.4; 3 p. m., 29.34; 6.30 p. m., 29.38, wind 79.2, lightening up in the northwest and clouds moving rapidly from north to south; 8 p. m., 29.46; 10 p. m., 29.54. 9th, 8 a. m., 29.68, wind north 20 miles.

Pensacola, Fla., 8th, rain continued from early morning and ended 8.15 p. m., with heavy northeast gales until late in the afternoon. The tide was higher than ever before.

Lake City, Fla., 8th, a heavy east storm occurred all day, which increased after dark to 40 or 50 miles with heavy rain; the storm increased in intensity until daylight of the 9th, when the wind was about 80 miles an hour with heavy rain.

Jacksonville, Fla., rain began at 10.40 p. m., 8th, with high wind and rapidly falling barometer. The early morning of the 9th the storm increased in violence; a maximum velocity of 62 miles southeast occurred at 5.45 a. m., being the highest velocity ever registered at this office. The rain ended at 9.30 a. m.

Charleston, S. C., 9th, rain continued all day, with high wind with a maximum velocity of 48 miles southeast. All shipping remained in port.

Charlotte, N. C., 9th, rain continued all day, ending at 7 p. m., the total amount being 3.80 inches. High wind prevailed during the day; maximum velocity 30 miles.

New York, N. Y., rain began 9th, 11 p. m., became heavy the morning of the 10th and ended at 12.45 p. m. It is roughly estimated that at least $1,000,000 worth of property was saved by the timely warnings.

Block Island, R. I., 10th, a severe storm set in at 12.45 a. m., accompanied by heavy rain, and increased in energy to a maximum velocity of 84 miles; storm ended at 9.25 p. m.

Narragansett Pier, R. I., 10th, rain began during the early morning, with a terrific northeast gale, the storm being the worst in several years.

Woods Holl, Mass., 10th, heavy rain began at 3.30 a. m., and continued until 11 p. m.; a severe gale blew from the northeast from 5 a. m., veering to east and southwest, with a maximum velocity of 60 miles per hour from the southwest. Owing to the timely warning given of the storm but few disasters were reported.

Boston, Mass., 10th, rain began about 3 a. m. and continued until 4.20 p. m., with high wind, reaching a maximum velocity of 49 miles east at 10 a. m. The timely warnings of the Bureau kept many vessels in port.

Portland, Me., 10th, rain began at 8.30 a. m. and continued until 8.12 p. m., with high wind. The storm was one of the severest that has ever occurred at this station.

In connection with this low area the following signals were ordered: 5th, 12.30 p. m., southeast, Key West. 6th, 10.55 p. m., northeast, Port Eads. 7th, 10.30 a. m., northeast, New Orleans to Tampa; 3.30 p. m., northeast, Galveston; 10.10 p. m., northeast, Jacksonville and section to Norfolk; 10.15 p. m., continue northeast, Port Eads; 10.20 p. m., continue information at Key West. 8th, 11 a. m., change to southeast at Tampa; 10.50 p. m., continue signals at Port Eads, Punta Gorda, Jacksonville to Norfolk. 9th, 8 a. m., southeast, Savannah and section; 10.50 a. m., northeast, Baltimore to Nantucket; 11 a. m., information, Portland and Eastport; 2 p. m., northeast, Boston and section; 4.40 p. m., southwest, Wilmington; 4 p. m., northwest, Savannah and section; 10.55 p. m., continue signals Morehead to West Point; information, Portland and Eastport. 10th, 9.50 a. m., northeast, Eastport and Portland; 9.50 a. m., change to northwest, Breakwater to New York; continue signals from New Haven to Woods Holl; 11.30 a. m., northeast signals at Oswego and section and Rochester; 8 p. m., northwest, New London. 11th, 10.30 a. m., information, Lake Ontario, Eastport, and Portland; 8.30 p. m., southwest, New York. For list of special warnings and other information, see Storm Bulletin No. 3 of 1894.

V.—On the 5th, a. m., low area No. V was central in British Columbia, having apparently moved rapidly southeast without much previous warning. By the 6th, p. m., this stretched as a trough from Colorado to Wisconsin, and then rapidly became an oval storm center over Lake Superior, while high area No. III moved southeast and was central in Colorado and Kansas. By the 9th, a. m., the low pressure was central at the mouth of the St. Lawrence, and by the 10th, a. m., it passed over Newfoundland into the Atlantic.

In connection with this area, the following signals were ordered: 6th, 6 p. m., southeast, Duluth and Ashland sections and Lake Pepin. 7th, 11 a. m., southwest, lakes Michigan and Huron, Sault Ste. Marie, and Marquette; northwest, Lake Pepin, Duluth, Houghton, and Ashland section; 10 p m., southwest, Lake Erie. 8th, 10 a. m., Lake Pepin, Duluth, Houghton, and Ashland section continue; other signals on lakes Michigan, Superior, and Huron changed to northwest.

VI.—On the 4th, p. m., pressure was low over the Gulf of California and at the same time began to fall in British Columbia. The southern area extended northward along the coast of California, while low No. V advanced southeast over British Columbia, and on the 5th, p. m., covered southern California and the adjacent Pacific. By this time the two centers, Nos. V and VI, were inclosed in a general depression covering California and the Rocky Mountain plateau. The

former depression moved steadily eastward, while the latter, separated from it by the southward movement of high No. III, filled up and disappeared in northern California.

VII.—On the 7th, p. m., and immediately in the rear of high No. III, a new depression advanced eastward over British Columbia and reached Manitoba by the 9th, a. m., when the hurricane (low No. IV) was central in Georgia. During the next twenty-four hours this depression rapidly broke up, while the hurricane center rapidly grew in size and intensity and had, by the 10th, p. m., reached that position in New England, toward which low No. VII was apparently moving.

The fact that in this, as in many other instances, the charts show the simultaneous presence of several centers of low pressure moving in different, and sometimes almost opposite, directions, sometimes approaching and sometimes receding from each other, proves that there must be a limit, depending upon the depth of the air and the extent of the whirl, beyond which the motions of these cyclones have little influence upon each other. The intermediate neutral region is usually the so-called area of high pressure, with its comparatively clear sky, light winds, and on the southern side falling, but on the northern side rising, temperatures. Just as the uprushes in a turbulent river afford the supply of water that overflows and descends into the little whirls, with their hollow centers, that dot the surface of the stream, so the high areas in the atmosphere furnish the descending air that feeds the ascending whirls of the low areas. The first tendency of the whirls in both the river and the atmosphere is to move inward toward the source of supply as fast as this becomes exhausted, and if it is continually renewed, their motion may become very slow; the second tendency of the whirl is to move together with the source of supply in the general direction down the stream, or, in the case of the atmosphere, in the temperate zones toward the east and in the torrid zone toward the west.

In connection with low area No. VII, the following signals were ordered: 9th, 5.30 p. m., northwest, lakes Superior and Pepin, except Sault Ste. Marie; 10.45 p. m., information at Buffalo and on Lake Ontario.

VIII and IX.—On the 10th, a. m., pressure began to fall in Alberta on the northern side of high No. IV, and in accordance with previous analogies this depression must already have had considerable motion toward the southeast. Its path was generally north of our stations, and on the 12th, a. m., the low area extended from Wisconsin northward to Hudson Bay. On the 12th, p. m., the extreme southern end of this depression, whose existence can be barely traced during the 11th as an incipient whirl in Kansas, Iowa, and Wisconsin, had become a well-marked storm center on Lake Michigan, whose track is given as low No. IX. While No. VIII broke up and disappeared in British America, the southern area, No. IX, rapidly developed into a well-marked whirl, which moved eastward on the 13th over the St. Lawrence through New England into New Brunswick, where it was central on the 14th, p. m., after which it passed to the Atlantic Ocean and apparently broke up.

In connection with low No. IX, the following signals were ordered: 13th, a. m., southwest, from Cleveland to Oswego, information from Detroit to Sandusky; 9.50 a. m., storm from New Haven to Woods Holl section, information at New York and from Boston and section to Eastport, lakes Erie and Ontario; storm northwest, lakes Huron and Michigan and at Sault Ste. Marie, Marquette, and Houghton section. 14th, 10.20 a. m., continue signals from Portland to Eastport, change Oswego to northwest; 3 p. m., information at Duluth, Lake Pepin, and Ashland. 15th, 10.30 p. m., information on Lake Erie.

X.—This number is given to one of the more interesting of the numerous areas of low pressure that appeared in Arizona. The low barometer that reached a minimum at Yuma on the 10th, p. m., apparently continued in that region until the 14th, p. m., while areas of high pressure, forming a continuous belt of high pressure, prevailed over the Rocky Mountains to the north and east, and in fact extended, on the average, from the south Atlantic coast west-northwest to California and Oregon. The location of the center is too uncertain to justify plotting its track. After the breaking up of this belt of high pressure, on the 17th the low area in Arizona and the low No. XIII off the coast of Oregon temporarily formed a continuous trough, and low pressure prevailed for several days along the entire Pacific coast, so that on the 18th, p. m., the lowest pressure of the month occurred at Yuma.

XI.—On the 12th, p. m., pressure was falling in British Columbia and Alberta. This depression remained at the northern end of our stations and evidently passed southeastward, until on the 17th, a. m., it was central at the mouth of the St. Lawrence, after which it passed to the Atlantic Ocean as an extensive storm center.

In connection with this area, the following signals were ordered: 16th, 9 a. m., southwest at Marquette, Sault Ste. Marie, and Huron, information on Lake Michigan; 10.45 a. m., southwest storm at Buffalo, Erie, and Cleveland; 10.55 a. m., lakes Huron and Erie; 1.30 p. m., southwest, Ontario; 6 p. m., northwest, Lake Huron, Sault Ste. Marie, Marquette, Green Bay and section, Houghton, and Mackinaw section. 17th, 12 m., northwest, Lake Huron, Sault Ste. Marie, Marquette, Mackinaw section, and Buffalo.

XII.—This was a West Indian hurricane whose history belongs to that of the North Atlantic storms, except only for the fact that on the 12th, and especially on the 16th, when its position and motion were as yet very imperfectly known, it was necessary to mention its existence in the general summary of weather conditions and to exhibit signals at Weather Bureau stations on the Atlantic coast as follows: 16th, 2 p. m., information, from Key West to Cedar Keys; 4 p. m., northeast at Cedar Keys, Tampa, Key West, Punta Gorda, Jupiter; 3.30 p. m., information at Jacksonville and section. 17th, 10.30 a. m., change to information at Cedar Keys, Tampa, Punta Gorda, and Jupiter.

XIII.—During the first half of October the general characteristic of the atmospheric movements was the prevalence of low areas over the Atlantic and of high areas over the United States, but on the 16th the inverse conditions began to prevail; the high areas prevailed to the east and farther to the west, leaving a series of indefinite low areas for several days over the western half of the United States. This series began with the appearance of low No. XIII *a* off the coast of northern California on the 16th, a. m., which depression, after moving inward, disappeared over Idaho on the 18th and 19th; its track is given on Chart I, although confessedly very unsatisfactory. On the 18th, a. m., area XIII *b* appeared in Nebraska as an independent center in the general depression that extended from the upper Mississippi southwest to the Gulf of California and northwest to British Columbia. This depression may be traced as a continuous whirl and slight depression to the 20th, a. m., by which time it, with XIII *c*, formed a continuous trough from Wisconsin to British Columbia, although afterwards they separated as independent depressions. The map of the 18th, p. m., also shows a third independent low area, XIII *c*, in British Columbia, where it had remained without motion and continued vacillating about that region until the 20th. On the latter date pressure was still decidedly below the normal from the Mississippi and Lake region west to the Pacific. Such a condition as this frequently happens on the Atlantic Ocean and over the United States and probably also over the North Pacific. Within the general depression moderate and indefinite depressions appear and disappear until the approach of a high area

gives occasion for the formation of a decided whirl and low barometer in some portion of the general depression. In the present case this event seems to have been the approach of low No. XV from the Pacific on the 20th.

After XIII *a*, *b*, and *c* had united on the 20th the depression lettered XIII *abc* moved northeastward to the north of Lake Superior, bringing heavy weather on that lake.

In connection with this area the following signals were ordered: 20th, 10.30 p. m., storm northeast at Duluth, southeast at Marquette; 21st, 11 a. m., southeast, lakes Michigan, Superior, Ontario, except northwest at Ashland, Houghton, and Duluth; information, Pepin.

XIV.—This was a West Indian hurricane whose details belong in great part to the storms of the North Atlantic Ocean; it was first located on the 22d at about N. 23°, W. 63°, from which position it moved eastward until, on the 25th, a. m., it was at about N. 26°, W. 76°, being then north of the Bahamas; its path now turned to the northeast at a considerable distance from the Atlantic coast until, on the 31st, it was central in N. 53°, W. 27°.

In connection with this hurricane, the following signals were ordered: 21st, 3 p. m., northeast, Norfolk section; 23d, 2.20 p. m., storm northwest, 2.50 p. m., from Key West to Jacksonville and section; information, at 2.50 p. m., from Savannah to Hatteras; 8 p. m., change to northeast at Jupiter; 10.20 a. m., information signals, Lake Pepin, Duluth, and Ashland section. 24th, 2.10 p. m., continue signals from Key West to Charleston, and from Wilmington to Hatteras; 2.40 p. m., information signals at Norfolk and section (except Hatteras) and Newport News; 9.50 p. m., southeast at Narragansett, Woods Holl and section; information at Boston and section. 25th, 10.50 a. m., change to information from Jacksonville to Key West; 1.50 p. m., northeast, Boston and section; 2.40 p. m., northeast at Sandy Hook, New Haven, New London, and Newport section; 10.05 p. m., continue northeast, Woods Holl and Narragansett section; 10.35 p. m., information signals at Eastport and Portland. 26th, 10.50 a. m., storm northeast at Portland and Eastport; 3 p. m., continue Boston and section. 29th, 9.55 a. m., northeast, Narragansett and Woods Holl section and Newport section. 30th, 10.30 p. m., northeast, Woods Holl, Henry, and Newport section; information at Sandy Hook. 31st, 10 p. m., southwest, Portland; southeast, Eastport; southwest, Boston and section; change to southwest, Woods Holl, Narragansett, and Newport section.

XV.—The general depression that had prevailed over the Rocky Mountain region from the 16th to 20th was evidently a southeastward extension of the low barometer that prevails in the northern Pacific, and is usually central in Bering Sea. A similar remarkable extension of the Atlantic low area will be recorded in the chapter on North Atlantic Storms. In the present case this depression culminated in the advance of low No. XV, which was off the coast of Washington on the 20th, a. m., and central in British Columbia on the 20th, p. m. It disappeared on the 22d, a. m., in Assiniboia, only to be followed immediately by No. XVI, which was central on the 22d, p. m., off the coast of Oregon.

XVI.—This depression passed northeastward into Alberta, where it was central on the 23d, a. m., while at the same time the low pressure prevailing to the westward showed that No. XVI was but the eastern end of a much larger depression. By the 25th this had become central in Manitoba, after which it began a remarkable southeastward movement, leaving its western companion, No. XVII, far in the rear. By the 28th, p. m., No. XVI had reached the coast of South Carolina, and there are few instances on record in which the southeasterly movement of a low area has carried it so far to the east, the usual path being more southerly over Kansas, and possibly Indian Territory, with an occasional passage southward over Texas into the Gulf. Having reached the South Carolina coast low No. XVI turned northeastward and was off the middle Atlantic coast on the 28th, p. m., and off Cape Cod on the 29th, p. m., after which it appears to have died out.

In connection with this low area, the following signals were ordered: 24th, 5.30 p. m., southeast, Houghton, Marquette, Sault Ste. Marie, Green Bay and section, Mackinaw section; information signals at Milwaukee and section, Chicago, Grand Haven and section. 25th, 10.30 a. m., northwest, Lake Pepin, Duluth, and Ashland section; southeast, Alpena, information at Mackinaw and Saginaw Bay section; 5.30 p. m., northwest, Michigan, Houghton, and Marquette; southeast, Saginaw, Port Huron, and Sault Ste. Marie; 10.40 p. m., southwest, Lake Erie. 27th, 10.40 p. m., information at Norfolk, Cape Henry, and Newport News. 28th, 10.35 a. m., information at Delaware Breakwater; 1.40 p. m., storm northeast at Cape Henry; 10.50 p. m., information at Woods Holl and Narragansett Pier.

On the 26th, a. m., low No. XVI was moving rapidly southeastward, and as stated in connection with that area, this southeasterly movement was taking place far to the eastward of the ordinary track of low areas. It is natural to associate this movement with the fact that the center of the hurricane, XIV, was at that time moving northeastward along the middle Atlantic coast. These centers were less than 1,000 miles apart, east and west, on the 26th, a. m., and their movements may have mutually affected each other, but there is not much tangible evidence of this. The south and east movement of No. XVI changed on the 27th into a northeast movement as it followed No. XIV, which moved much more rapidly. That two such well-marked cyclones should cross each other's track and change their directions of motions in such close proximity to each other well illustrates the mobility of the atmosphere, and the fact that the motion of each area is influenced largely by the independent thermodynamic changes that are going on within its own boundary quite as much as by the dynamic phenomena of the general atmospheric motions.

XVII.—This was central on the 25th, p. m., in Alberta. It moved eastward and then suddenly southward until, on the 27th, a. m., it extended as an oval from Colorado to North Dakota; it then moved eastward, becoming a well-marked storm center on the 28th, and passed over Lake Superior; it broke up temporarily in the Lake region on the 30th, but developed into a new storm center that was central on the 31st in the St. Lawrence Valley.

In connection with this low area, the following signals were ordered: 27th, 9.30 p. m., storm northeast at Duluth, southeast at Marquette and Green Bay. 28th, 11 a. m., northwest at Duluth, Ashland, and Houghton; information signals at all other stations on lakes Superior, Michigan, and Huron.

XVIII.—On the 29th, a. m., this low area was central in Alberta, while high No. XI was central in Utah and low No. XVII was over Lake Superior. Area No. XVIII moved slowly eastward, and No. XVII almost entirely disappeared as a separate center until, on the 31st, a. m., they may be considered as having united north of the Lake region.

XIX.—This appeared on the 31st, p. m., in northern Alberta, and its further history belongs to November.